

REMARKS

Claims 1-17 are pending in the application. Claims 3, 7-14 and 17 have been withdrawn from consideration. Favorable reconsideration of the application is respectfully requested.

I. REJECTION OF CLAIMS 1, 2 AND 15 UNDER 35 U.S.C. § 103(a)

Claims 1, 2 and 15 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Naito et al. (U.S. Patent No. 5,646,953) in view of Takeya et al. (U.S. Patent Application Publication No. 2003/0136970). The Examiner acknowledges that Naito et al. fails to disclose: (1) a second p-type nitride semiconductor layer containing Mg, (2) the first p-type nitride semiconductor layer being located between the active layer and the second p-type nitride semiconductor layer, and (3) the second p-type nitride layer having a greater band gap than a band gap of the first p-type nitride semiconductor layer. It is the Examiner's position that it would have been obvious based on the teachings of Takeya et al. to have modified the semiconductor device of Naito et al. to include these missing features, as Takeya et al. teaches placing a p-type (Mg-doped) GaAlN electron blocking layer (EBL) so that the waveguide layer is between the EBL and the active layer. The Examiner states that the EBL would have to have a bandgap larger than that of the waveguide layer for the blocking layer function to occur, and further, that in the semiconductor art it is well known that Mg is typically used as the p-type impurity in GaAlN.

With regard to the method recited in claim 15, the Examiner acknowledges that Naito et al. fails to disclose the specifics of the MOCVD method. Nevertheless, it is the Examiner's position that it would have been obvious to have grown the GaAlN p-doped layers of Naito et al. using the MOCVD method, including using a source gas containing Al and Mg, as taught by Takeya et al.

Applicants respectfully traverse the rejection for at least the following reasons. Claim 1 recites a nitride semiconductor device comprising a p-type nitride semiconductor layer, an n-type nitride semiconductor layer, and an active layer interposed between the

p-type nitride semiconductor layer and the n-type nitride semiconductor layer. The p-type nitride semiconductor layer includes: a first p-type nitride semiconductor layer containing Al and Mg; and a second p-type nitride semiconductor layer containing Mg. The first p-type nitride semiconductor layer is located between the active layer and the second p-type nitride semiconductor layer, and the second p-type nitride semiconductor layer has a greater band gap than a band gap of the first p-type nitride semiconductor layer. Claim 15 is directed to the method of making the nitride semiconductor device.

According to the present invention, by adding Al source gas (TMA) to grow the first p-type nitride semiconductor layer, the doping lag of Mg (Memory effect) is suppressed. This is because, since the reactivity between Mg and Al is very high, if Mg is added to a source gas that contains Al, Al and Mg immediately react to form a complex, without adhering to the pipes or the inner walls of the reactor, and thus are taken into the crystal (see page 36, line 16 to page 37, line 1 of the present specification). Such phenomenon was discovered by Applicants. Naito et al. and Takeya et al. fail to recognize the problem of the “memory effect” associated with Mg doping, let alone the phenomenon caused by Al.

Claims 1 and 15 recite “a first p-type nitride semiconductor layer containing Al and Mg; and a second p-type nitride semiconductor layer containing Mg, the first p-type nitride semiconductor layer being located between the active layer and the second p-type nitride semiconductor layer”. The Examiner’s position appears to be that the first p-type nitride semiconductor layer of the presently claimed invention corresponds to the undoped InGaN optical waveguide layer 8 of Takeya et al., and the second p-type nitride semiconductor layer of the presently claimed invention corresponds to the p-type AlGaIn electron blocking layer 11 of Takeya et al. (page 3, lines 8-9 of the Office Action). However, the undoped InGaN optical waveguide layer 8 of Takeya is an n-type layer (paragraph [0085] of Takeya et al.), while the first p-type nitride semiconductor layer of the presently claimed invention is a p-type layer. Takeya et al. neither teaches nor suggests providing a first p-type nitride semiconductor layer containing Al and Mg between the active layer and the second p-type nitride semiconductor layer. Thus, Takeya et al. does not cure the deficiencies of Naito et al. Even if one skilled in the art

were to combine the teachings of Naito et al. with those of Takeya et al., the resulting combination would not include all of the recited features of the claimed invention. Accordingly, prima facie obviousness has not been established, and the rejection of claims 1, 2 and 15 under 35 U.S.C. § 103(a) should be withdrawn.

II. REJECTION OF CLAIMS 4-6 AND 16 UNDER 35 U.S.C. § 103(a)

Claims 4-6 and 16 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Naito et al. and Takeya et al. and further in view of Okumura (US 6,456,640).). The Examiner acknowledges that the combined teachings of Naito et al. and Takeya et al. fail to disclose a non-doped third layer between the active layer and the first layer, wherein the third layer contains Al, has a bandgap equal to the first layer, and which bandgap is smaller than the bandgap of the second layer. The Examiner contends that it would have been obvious, based on the teachings of Okumura, to have modified the first p-type layer of Naito et al. by replacing it with a GaAlN layer including a third layer that is non-doped and that is next to the active layer.

Applicants respectfully traverse the rejection for at least the following reasons. As discussed above, even if one skilled in the art were to combine the teachings of Naito et al. with those of Takeya et al., the resulting combination would not include all of the recited features of the nitride semiconductor device of claim 1. Because Okumura fails to cure the deficiencies of the combination of Naito et al. and Takeya et al., the rejection of claims 4-6 and 16 under 35 U.S.C. § 103(a) should be withdrawn.

III. CONCLUSION

Accordingly, all claims 1, 2, 4-6, 15 and 16 are believed to be allowable and the application is believed to be in condition for allowance. A prompt action to such end is earnestly solicited.

Should the Examiner feel that a telephone interview would be helpful to facilitate favorable prosecution of the above-identified application, the Examiner is invited to contact the undersigned at the telephone number provided below.

Should a petition for an extension of time be necessary for the timely reply to the outstanding Office Action (or if such a petition has been made and an additional extension is necessary), petition is hereby made and the Commissioner is authorized to charge any fees (including additional claim fees) to Deposit Account No. 18-0988.

Respectfully submitted,

RENNER, OTTO, BOISSELLE & SKLAR, LLP

/Heidi A. Boehlefeld/

Heidi A. Boehlefeld

Reg. No. 34,296

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The Keith Building
1621 Euclid Avenue
Nineteenth Floor
Cleveland, Ohio 44115
(216) 621-1113